

White Paper

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Project Title:

Scientific Workflows, Image Analysis, and Visual Stylometry in the Digital Analysis of Art

Project Directors: Catherine Buell, Fitchburg State University; Ricky Sethi, Fitchburg State University; William Seeley, Boston College

Grantee Institution: Fitchburg State University

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Project Activities/Accomplishments

We have successfully met our major goals for this project and exceeded our expectations in many of these directives. We have several workflows up and running: Entropy, DTM, and Background Extraction, and CNN. There are additional components that are currently in progress above these tests. We are also working to create a cluster to run these components more efficiently. Recently, we have brought in the User-Interface Designer and will have more progress on that portion of the project.

We have developed two large image sets to use to develop our research: 82 Andrew Wyeth's (20 drybrush; 25 watercolor; 39 egg tempera) and 180 landscape paintings (90 Impressionist/ 90 Hudson River; 30 each - Sisley, Monet, Renoir, Cole, Church, Bierstadt). The groundwork has been set for a collaborative study with Shelley Reed in conjunction with her show at the Fitchburg Art Museum. Shelley provided us with 5 images and their stylistic inspirations. We are working on an image set of Superrealist paintings (30 images each from Richard Estes, Rackstraw Downes, and Robert Bechtle) to match the Impressionist and Hudson River School image sets.

Beginning in January, the Fitchburg State University (FSU) research group with members Dr. Buell, Dr. Sethi, several current FSU undergraduates, graduate students, and an alumni met weekly. Included in this group was our User-Interface designer. This group completed our workflows to include: GetEntropyImage, GetEntropy, GetEntropyImage, GetEntropyNeighborhood, GetDTMValue, GetDTMImage, StylizedImage1(2), Convert_to_Grayscale, HSV, Sobel and Canny Edge Detection, Rotate, Vertical_Wave, Horizontal_Wave, and Blur.

One of the graduate students, RaghuRam Rangaraju, worked on modifying the original WINGS interface and explore options for customizing the Ext.JS framework. In addition, he helped develop a new Bootstrap JavaScript prototype of the new WAIVS interface (<http://prototype.waivs.org/>). Another graduate student, Swaroop Krothapalli, helped create a thorough experimental framework to evaluate various machine learning algorithms on our datasets. This included Random Forests, XGBClassifier, Logistic Regression, and SVM; for all of these, we were able to calculate Precision, Recall, F-1, and Mean Accuracy.

Due to the scheduling of exhibits at the Fitchburg Art Museum, the installation of WAIVS at the Fitchburg Art Museum was put in mid-March and was removed at the end of the exhibit (Shelley Reed's *A Curious Nature*) in the beginning of June. In preparation for the installation, several tutorials were created to guide the user through the system. Also, a dedicated machine was created to run the workflows.

The workshop was held May 19th at the Fitchburg Art Museum. Again, there were several meetings throughout December and May with FAM's museum curator, education director, director, and event coordinator. The Making WAIVS! workshop was attended by around 35 people, more than 20 art historians, mostly in the New England area, and about a dozen students and enthusiasts. It was partially-supported by the American Society for

Aesthetics and the New England Museum Association. The discussions centered on possible approaches to quantifying artistic style. WAIVS project members demonstrated workflows to compute the entropy of a painting and other quantitative ways to represent a painting, art historians discussed the possibilities of using such measures to design more formal descriptions of artistic style. Surveys were conducted (with appropriate IRB approval) and will be used for future research endeavors as well as to modify WAIVS functionality.

Changes to Project Plan/Hardware/Software/Staffing

The role of consultants has changed slightly from our original plan. While the role of our partnership with the Fitchburg Art Museum (FAM) had not changed, it has expanded. FAM has expanded our network to work with the New England Museum Association (NEMA). NEMA has agreed to help with the registration and advertisement for the workshop. FAM has also connected us to the local artist Shelley Reed who will have work on display during the time WAIVS will be in the Learning Annex. We also have commitments from speakers for the workshop. Our original speakers: FAM representatives, Yolanda Gil, and Charlene Villasenor Black will be joined by a new addition Daniel Graham (Visual Stylometry).

In regards to hardware, we found had additional resources from Fitchburg State University to create a supercomputer cluster; however, we lacked the time to get this up and running. Instead the project ran on a dedicated computer with a specialized graphics card and Amazon Web Services. On the software end, the interface was trimmed back to be an interface that would work across any platform (mobile device or desktop device) but we didn't have a functional User-Interface outside of the WINGS interface. We were able to modify the WINGS interface to make it more user-friendly during the workshop. This change is discussed further in the section below.

In regards the staffing, the main staffing problems were getting a UI Designer for the budgeted amount; we realized we would need a second round of funding to hire a full-time UI Designer for in-depth development and we instead scaled back the UI Designer's role in this stage to be a consultant to formulate the specifications at the workshop (which was the original goal) and create a mockup of the final interface. We intend to apply for funding through another opportunity or through the NSF Cyberlearning to both develop the platform and great educational packages for college classrooms and researchers.

The project was publicized through several newspaper articles, blog articles, the workshop, and professional talks.

Audiences

The audience for our project includes a range of people, from laypersons interested in getting a deeper understanding of artworks to humanities scholars interested in expanding their research by including cutting edge machine learning algorithms and tools. In the workshop, participants ranged from students, both in the humanities and the sciences, to researchers and professionals. Participants came from the local New England area, the West Coast, and even Europe, and

ranged in age from undergraduates to graduate students to seasoned researchers and professionals. The institutions represented at the workshop also ran the gamut from Tier 1 Research Institutions to Local Colleges to Museums and un-associated professionals.

The workshop opened avenues for new audiences by allowing science students interested in understanding the research issues and challenges in analyzing artworks to start to develop an understanding of what's involved in the field. Humanities students, on the other hand, learned about the availability of tools and techniques which have been otherwise prohibitive for them. Finally, science researchers were able to expand their research to a new area in art analysis while humanities researchers and museum professionals were also introduced the wide variety of tools that would be accessible to them now. In addition, the exhibit materials were also offered in Spanish to appeal to the local Latino population. Details of the workshop can be found at <https://www.isi.edu/ikcap/news/WAIVS-2017/> and <http://fam.waivs.org/>

Evaluation

Given the primary stage of the project, the project was evaluated by a small group of users involved with the project, a group of workshop attendees, and from surveys as part of the public display.

Only two surveys came from the public display. They were done by people who worked at the museum. A bulk of the feedback from the public came from the workshop who identified themselves as museum educators, art historians, philosophy of art scholars, contemporary art scholars, collections managers, and photographers,

Some questions and responses are featured below:

What do you like most about WAIVS?

Entropy Analysis.

Viewing just the lines and removing color.

Ability to 'look' at images differently.

Superimposing the different techniques from one artist to another.

The possibility to search for similar imagery/iconography/content/style/color palettes, etc.

Access to filters for research and teaching.

What do you like about the interface? What would make it better?

It is PC friendly, art museums are PC friendly. Need sample values/ranges.

Not intuitive without instructions.

Lots of options and still in progress. Need to preview original image.

Make uploaded images visible.

More user-friendly for non-computer folks.

The prototype seems great. It should be workable across many devices.

Do you find this tool useful for your research/teaching/interests? Is there anything we could do to enhance the accessibility/usability to fit your needs?

The interface is clunky in place. What about other analysis? Like electron microscopic analysis.

Down the road helping to identify styles of imagery.

Less technical language. Simplify terminology and interface.

Enhance by being able to distinguish materials/thickness of medium/ angle of brushstroke/visibility of brushstrokes.

Teaching--yes. Research--eh....

Standardization of digital files/input like the Getty Identification catalog would be helpful.

What would make you most likely to use WAIVS?

Free.

Combine it with image generation technology.

Easy to use, easy to search artists' websites and auction house databases.

More direction applications for research.

What would you expect from a final WAIVS platform?

Cloud-based with interface images.

Ways to suggest new functions.

More mainstream applications for art appreciation.

From users including interns, research students, the user-interface designer, workshop speakers, and co-PIs, our assessment is that the interface itself needs much improvement beyond the capabilities of the Wings platform. Also, the Wings platform is lacking the ability to input multiples images at once and display which does not support the needs of many researchers. However, the tool itself seemed to support the software and created research quality results of interest to the parties involved. We have prepared more research tools, but these rely on the input of multiple images.

Continuation of the Project

The three Co-PI's on the grant developed a strong collaborative relationship around their shared interdisciplinary interests. Plans are in the works to continue the research and expand the scope of the project. We will submit an application for a *Level III Digital Humanities Advancement Grant* in the spring of 2018. This grant will include the addition of Yolanda Gil, Director of Knowledge Technologies, Information Sciences Institute, University of Southern California as a Co-PI. The inclusion and Dr. Gil and her Interactive Knowledge Capture research group will provide the skill set and resources necessary to develop and implement WAIVS as a powerful,

accessible, open source, professional level tool for research and pedagogy in schools and museums. In addition plans are in place for a collaboration on a new project spearheaded by Dr. Sethi, *Extinguishing the Backfire Effect: Using Emotions in Social Collaborative Argumentation for Fact Checking*. The goal of this project is to develop software to help explore the role of affective variables in reasoning and decision-making.

We are currently in the process of writing a research proposal to the Wyeth Foundation for access to their database of high resolution images of Andrew Wyeth's paintings. Plans are also in the works to reach out to the Farnsworth Museum and the Addison Gallery of American Art to collaborate with their education departments and gain access to their collections. Preliminary exploratory conversations with both institutions have been positive. In the near future plans are in place for submissions to the 2018 meeting of the *Association for Psychological Science* and the 2019 *Pacific Division Meeting of the American Philosophical Association* to present the results of continuing research.

We are interested in continuing the relationship with NEMA and FAM is interested in continued educational opportunities for the university, the community, and local artists.

Long Term Impact

William Seeley teaches a First Year Seminar called *The Power of Art* that explores the role cognitive science can play in fostering our understanding of art. He plans to integrate the WAIVS software into the curriculum for the class, using it to introduce students from a broad array of disciplinary backgrounds to questions about artistic style, categories of art, and the structure of the concepts we use to represent each. Professor Seeley has also used the project research to introduce students in philosophy of art classes to STEM related concepts and the psychophysiological foundations of object recognition.

FAM is interested in using the software and other local museums if it can be modified with a highly modified user interface. Right now, our institution is interested in assisting the research group to create a cluster to host the system.

Grant Products

WAIVS website, www.waivs.org (Web Resource)

Making WAIVS! on Wings (Computer Program)

Making WAIVS! Workshop website, fam.waivs.org (Web Resource)

Sample Tutorial, w1.waivs.org/wings-portal (Web Resource)

Conference Paper/Presentations:

- Reproducibility in computer vision: Towards open publication of image analysis experiments as semantic workflows, *IEEE International Conference on eScience (IEEE eScience)* (2016)
- Seeking Salience: What Can Computer Science Teach Us About Engaging Artworks? *CLA Speaks Series: Visualization, Storytelling, and Imagination*, Cal Poly, San Luis Obispo, California, November 2017
- Digital Image Analysis, Philosophy, Cognitive Science, and the Question of Artistic Style, *Making WAIVS! Workshop on Workflows for the Analysis of Images and Visual Stylometry*, Fitchburg Art Museum, Fitchburg, Massachusetts, May 2017.
- A Question of Artistic Style: Digital Image Analysis and the Classification of Paintings (with Catherine A. Buell, Fitchburg State University), *American Society for Aesthetics, Pacific Division Meeting*, Asilomar Conference Grounds, Pacific Grove, California, April 2017.
- What Can Cognitive Science Tell Us about Art? *Franklin W. Olin College of Engineering*, Needham, Massachusetts, March 2017.
- Making WAIVS! Workshop and Talks

Introduction to Visual Stylometry

Daniel Graham

Assistant Professor of Psychology Research Associate Division Director for
Hobart & William Smith College

WINGS technology

Yolanda Gil

USC, Information Sciences Institute

WAIVS demonstration

Catherine Buell

Assistant Professor of Mathematics
Fitchburg State University

Utility to Museums and Art Historians

Charlene Villaseñor-Black

Associate Professor of Art History, UCLA

Implications in Humanities, Philosophy, and the Arts

William Seeley

Visiting Scholar in Psychology
Boston College

Publications, Conference Paper/Presentations submitted or in preparation:

- Democratizing the Visual Stylometry of Art: Analysis of Artistic Style through the Computational Workflows, *Communications of the ACM (CACM)* (submitted).
- Categories of Art and Computers: A Question of Artistic Style. *American Society for Aesthetics Newsletter* (in preparation).

- Computers, Cognitive Science, and Artistic Style: Using Digital Image Analysis Techniques to Study the Grounds for Categorization Judgements in Viewer Engagement with Paintings (in preparation).
- Using computers to better understand art, *The Conversation blog article*.

Media Coverage

- *Cal Poly to Host Talk with William P. Seeley on Nov. 2*,
https://calpolynews.calpoly.edu/news_releases/2017/October/Seeley;
<https://cla.calpoly.edu/claspeaks>
- *Workshop On Digital Image Analysis*, *American Society for Aesthetic newsletter*, 37(1), 2017: 13-14.
<http://c.ymcdn.com/sites/aesthetics-online.org/resource/resmgr/newsletters/37.1.pdf>
- *Visual Stylometry Team, including Bill Seeley, Wins NEH Digital Humanities Start-Up Grant*, Grants@Bates, April 2016,
<https://www.bates.edu/grants/previous-issues-grantsbates/>
- *Fitchburg State faculty receive grant to further develop art-study tool*, Sentinel & Enterprise article.
- *Faculty members awarded national grant for art exploration*, newsletter from Fitchburg State University.
- *Where the canvas meets the code*, Sentinel & Enterprise article.
- *Using Intelligent Workflows to Analyze Artistic Style*,
<https://www.isi.edu/ikcap/news/WAIVS-2017/>